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ABSTRACT

The effects of advance organizer instruction on the acquisition of number, mass, area, quantity, and length conservation concepts in 3- and 4-year-old children are examined. Participating in the experiment were 28 children, a total of 14 in respective experimental and control groups. All children were pretested and determined to be nonconservers. A sequence of two advance organizer lessons was presented to the experimental group: the first concerned paying attention to special properties of objects, while the second focused on use of high-order rules for solving conservation tasks. Control group children received regular instruction in a preschool program using a guided-discovery method of instruction. Posttests were conducted immediately after the training period, to measure immediate transfer of training, and after about 4 weeks, to measure long-term retention of conservation concepts. Results indicated that advance organizer instruction was successful in promoting the learning of a high-order rule for conservation that children generalized to the five conservation concepts. The high level of improved performance by the experimental group at the first posttest was maintained at the second posttest. Control group children showed little improvement in performance in either posttest, and their level of performance remained essentially preoperational. (Author/MP)

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EFFECTS OF ADVANCE ORGANIZER AND GUIDED-SELF-DISCOVERY INSTRUCTION ON PRESCHOOL CHILDREN'S UNDERSTANDING OF CONSERVATION

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Abstract

This study examined the effects of advance organizer (AO) instruction on the acquisition of number, mass, area, quantity, and length conservation concepts in three- and four-year-old children.

Twenty eight children participated in the experiment, with fourteen in each of the experimental (E) and control (C) groups. All children were pretested and determined to be nonconservers. A sequence of two advance organizer lessons on paying attention to special properties of objects and the use of high-order rules for solving conservation tasks along with related learning activities was presented to the experimental group. Control group children received regular instruction in a preschool program using a guided-discovery method of instruction. In this program, children did have access to materials that might be used for discovering conservation concepts. However, acquiring such concepts was not an objective of this program's curriculum. Posttests were conducted immediately after the training period to measure immediate transfer of training, and after about four weeks to measure long-term retention of conservation concepts.

Results indicated that AO instruction was successful in promoting the learning of a high-order rule for conservation that children generalized to five conservation concepts. The high level of improved performance by E group children at posttest was maintained at delayed-postest. C group children showed little improvement in performance in posttests I and II and their level of performance remained essentially preoperational. All children found number conservation easiest to deal with. Apart from number conservation, performance by the E group on the remaining conservation tasks was closely comparable at posttest and delayed-posttest. However, there was some indication that order of acquisition of the five conservation concepts was: number, quantity, length, area, weight (mass).

EFFECTS OF ADVANCE ORGANIZER AND GUIDED-SELF-DISCOVERY INSTRUCTION ON PRESCHOOL CHILDREN'S UNDERSTANDING OF CONSERVATION

Introduction

This study examined the effectiveness of advance organizer instruction in paying attention to special properties of objects and the use of a high order rule for conservation compared to a guided self-discovery approach in influencing preschool children's understanding of five conservation concepts: number, mass, area, quantity, and length. Children who were in the experimental group received advance organizer instruction in accordance with Ausubel's theory of subsumption learning. Children in the control group attended a traditional type of preschool program in which they were encouraged to engage in exploratory discovery learning.

Piaget (1970) has stated that stage-related concepts such as conservation can be responsive to training on two conditions: that learning of a concept occurs only when it is understood by children to some measurable extent, and if the training procedure resembles the kind of situation in which intellectual development occurs in everyday life. In other words, for understanding of a concept such as conservation to be meaningful, children must discover it for themselves as an outcome of interactions with the environment. As children approach a logical understanding of the concept, guided-self-discovery instruction is expected to help the child to a final state of understanding (equilibration).

A variety of training procedures have been used to induce conservation in children. The most notable use of the guided-self-discovery methods has been that by Genevans themselves (Inhelder, Sinclair, & Bovet, 1974). Various tutorial approaches have been used such as verbal rule instruction (Beilin,

1965; Brainerd, 1974; Carlson, 1967; Denny et al., 1977; Hamel & Riksen, 1973; Lawton, 1983; Lawton, Hooper, Saunders, & Roth, 1983; Rosenthal & Zimmerman, 1972; Siegler, 1972; Siegler & Leibert, 1972; Shephard, 1973, 1974; Sjoberg et al., 1970; Zimmerman & Lanaro, 1974; Zimmerman & Rosenthal, 1974). Tutorial methods have usually proved to be more successful in inducing conservation than the self-discovery approach.

Of particular interest to this study is the research of Gelman (1969) and recent research by Lawton (1983) and Lawton et al. (1983). Gelman trained five-year-old children, established as being non-conservers, quantity attributes on problems related to conservation. The objective was to train the children to attend to relevant properties of objectives to establish sameness, same number, same length. This was accomplished through "oddity" training. At immediate posttesting the trained children showed significant improvement over their pretest performance on number and length conservation problems and performed well on liquid and weight tasks (non-specific transfer). This level of performance was maintained on delayed posttests three weeks later.

Lawton (1983) and Lawton et al. (1983) have had success in inducing conservative in preschool children using advance organizer instruction. However, no attempt has previously been made to teach, by this method, a general procedure for attending to special properties of objects during and following a transformation of an object, nor in the use of a general rule for solving conservation problems that can be applied to a class of similar problems. The advance organizer instruction procedure is based on Ausubel's subsumption learning theory (Ausubel, Novak, & Hanesian, 1978). Either superordinate concepts or high-order rules are presented first in the instructional sequence in what is called an "advance organizer" lesson. Being

provided with, say, a high-order rule for solving conservation problems in general, children are prepared "in advance" of particular instances of conservation problems (related learning activities) to which the single, high-order rule can be applied. Learning how to deal with particular instances of conservation is expected to "progressively differentiate" the general rule. It is predicted that the end result of this sequence of learning--advance organizer lesson followed by related learning activities--will be the meaningful learning and committing to long-term-memory of the high-order-rule. It is expected that, if understanding and learning of the high-order rule has occured, children will then apply it successfully to the solving of problems in that category of problems that established the parameters of rule-use during training.

Subjects

The participants in this study were 28 middle-class children of mixed ethnic origin, with 14 in each of two preschool programs. Program A was a formal structured preschool where the instruction process was based on Ausubel's theory of learning (the experimental program). Program B was a community preschool where the program was not based on any particular theory (the control program). The mean chronological age of children was 4 years (range: 3 years, 1 month, to 4 years, 8 months) in Preschool A, and 3 years, 11 months (range: 3 years, 1 month, to 4 years, 8 months) in Preschool B. All children attended school five days per week.

Design

This study used a pretest-training-posttest-delayed-posttest design. Subjects in each preschool were pretested to initially determine who were conservers and nonconservers. Following pretesting, only nonconservers were included in the study.

The training followed immediately after pretesting, and lasted for two weeks. Posttests were conducted immediately following the training period and delayed-posttests were administered four weeks following training to measure long-term retention of conservation concepts following instruction.

The pretests and posttests consisted of a battery of conservation tasks. The teaching consisted of a set of advance organizer lessons and related learning activities presenting general rules for solving conservation problems. The instructional procedure is described in a following section.

Tests and Scoring Procedure

The battery of conservation tests for pre-, post-, and delayed-posttests consisted of problems on the conservation of number, length, weight (mass), quantity, and area. Each problem had two sub-tasks. For example, the conservation of number problems consisted of the following sub-tasks:

Conservation of Number

1. Pretest: This consisted of presenting two rows of six pennies in one-to-one correspondence. For sub-task 1, the first row of pennies was expanded in length, and the question was asked, "Does this row (pointing to the transformed row)". In sub-task 2, one row of pennies was transformed into a heap and the question was asked, "Are there as many pennies here (pointing to the row) as there are here (pointing to the heap)?". Similar questions were asked for each transformation in all the conservation tasks.

2. Posttest: This consisted of presenting two rows of four flowers each in one-to-one correspondence. The first transformation (sub-task 1) was the expansion of one row of flowers. The second transformation (sub-task 2) involved piling one row of flowers on topic of each other.

3. Delayed-Posttest: This consisted of presenting two rows of four

beads each, in one-to-one correspondence. The first transformation was the expansion of one row of beads, and the second transformation consisted of heaping one row of beads.

Each correct conservation response, with a correct explanation, was scored 1. Since there were five conservation tasks, each consisting of two sub-tasks, the total possible score at each time of testing was 10.

Children were tested individually in all problems. The testing order of the tasks was identical for each subject and the testing sessions were conducted with the tester and the child sitting at a table across from each other. Each session lasted about ten to fifteen minutes, and the order of presentation of transformations was randomized.

Teaching Materials

There were two advance organizer (AO) lessons. In the first AO, children were taught the general concepts of object, property, and special property. In the second AO they were taught a high-order rule for solving conservation problems within a specified class of conservation concepts comprising the concepts of number, length, quantity, weight (mass), and area.

Materials used in AO I were a chair, a jacket, three glasses, water, three pieces of rope, five pennies, four pencils, three blocks, four crayons, three pieces of paper, four pieces of string, and playdough.

Materials used in AO II were five blocks, playdough, three glasses, water, pieces of string, and pieces of paper.

Materials employed in the Related Activities (RAs) were a flannel board (to present stories), pictures, drawings, and cut-outs of an elephant, tiger, alligator, monkey, zoo-keeper, two boys, girl, woman, cookie dough, two witches, three beakers (two being of the same size), colored water, two

pencils, pieces of paper.

Teaching Procedure

The training period lasted for one-and-a-half weeks and consisted of two advance organizers and a set of related activities. Each training session was conducted with small groups of three to five children, and each small group lasted for a period of fifteen to twenty minutes. Identical teaching methods were utilized and the groups received all the organizers and related activities. Instruction was provided by the second author. Both the AOs were conducted in question-answer type sessions and the teacher ensured that as far as possible, children were given a chance to answer questions, discuss changes, and manipulate materials. Answers to questions were provided only if the children could not supply the answer or supplied incorrect explanations. The following is an editorialized, shortened example of AO1 followed by a similar example of AO2.

Advance Organizer I

The teacher introduced the concepts "object", "property", and "special property".

Teacher: Let's look at all the different things in this room. Another word for "thing" is the word "object". Can you say that? Child: Object. Teacher: Good! There are many objects in this room. Let's see if we can find some objects. Can you find a chair in the room? Child: (Find a chair). Teacher: Is that chair an object? Child: Yes. Teacher: Let's see if we can find a jacket. Child: (Find the jacket). Teacher: Is that jacket an object? Child: Yes. Teacher: Let's see if we can find a glass. Child: (Find a glass). Teacher: Is this glass an object? Child: Yes. Teacher: There are

special things about every object and these special things are called properties. Can you say property? Child: Property. Teacher: Good! Now let's take this jacket and look at it carefully. These are some of the special properties of this jacket: It has sleeves, it has pockets, it has a zipper, it has a hood. What other properties does it have? Child: It is white. Teacher: Good. It is white. That's a property the jacket has. Let us put away this jacket and look at this glass. What are some of the special properties of this beaker? Child: It is made out of glass. It will break if it is dropped. It is round. It's tall. Teacher: OK, let's look at these three pieces of rope. Is a rope an object? Child: Yes. Teacher: Can you tell me some of the properties of this ropes? Child: One is longer than the others. They are all white. Teacher: How do they feel? Child: Rough. Teacher: What can they be used for? Child: To tie things up. Teacher: So, objects have many different properties that we can look for.

The remainder of the organizer was presented in the above fashion, with the teacher asking questions and helping the children respond. Questions also invited children to generalize the concept of object and property to objects that had properties of number, length, mass, quantity, and area. For example:

Which glass has the most amount of water? Which glasses have the same amount of water? Which glass has the least amount of water? Let us look at one more special property. Let's look at area. Area means the amount of space you have. Can you look at these pieces of paper (five pieces of paper)? Some of them have the same amount of space on them don't they? Can you show me which pieces have the same amount of space? Which piece has more paper? Which piece has less paper?

Advance Organizer II

The subjects were reminded about the important aspects of advance organizer I--Objects, properties, and special properties. Then the teacher proceeded:

Teacher: Do you remember the last time you were here? We talked about looking at one special property of an object or objects. Sometimes when the special property of an object is not changed, other properties of the object are changed. Here is an example. Let us look at this group of blocks here. What are the properties of these blocks? Child: There are five blocks, they are square, they are hard, they are all red, they are laying side by side. Teacher: This group of blocks has many properties. Now let us look at one special property; let's look at number. How many blocks are there? Child: Five. Teacher: What special property did we look at? Child: Number. We looked at how many blocks there are. We counted five. Now let us put the blocks one on top of the other. They look different don't they? They are now standing one on top of the other. Even though they look different, has the number of blocks changed? Child: No. Teacher: How many blocks do we have? Child: Five. Teacher: How do you know that we still have five? Child: We counted. Teacher: OK, now what if I added one block to this group of blocks? Do we still have five? Child: No. Teacher: How many blocks do we have now? Child: (counting) Teacher: OK. Six. Now what if I took away one block from the five blocks, how many would I have? Child: Four. Teacher: So the special property we are looking at changed when we added something to or took away something from the special

property, number. When we change the shape of the five blocks how can the special property, number, stay the same? Child: Don't add any blocks. Teacher: And? Child: Don't take away a block. Teacher: Good!

The remainder of the organizer was presented in the above fashion, with the teacher asking questions and helping the children answer. Each of the five conservation concepts was treated in this fashion. It is important to add here that (1) none of the materials used in the test battery were included in these instruction sequences, and (2) the children were never asked to solve an actual conservation problem.

Related Activities

The following is an example of one relation activity during which children had the opportunity to apply the concept "special property" and the rule to find out whether a property has changed; then check to see if anything as been added to or taken away from the special property.

Teacher: Do you remember the last time you were here? We talked about looking at one special property of an object. We also talked about a rule that we can use to tell whether a special property has been changed or not. Let's see if we can remember the rule. Now I have some stories to tell you.

A flannel board and the cut-outs were used as illustrations. The stories were accompanied by appropriate actions.

Teacher: Here is a zoo and here is a zoo-keeper. One day, four new animals joined the zoo. Here they are. (Put out elephant, tiger, alligator, and monkey.) The zookeeper lined up all the animals, told them to stay where they were, and said that he would find their cages

and then come back to get them. He said to himself, "I have four animals here (count with children) all in a row." As soon as he left, the animals decided to run away in all different directions. When the zookeeper came back, he took one look and said, "Oh no! The animals have run all over the place. He had to go and find them and bring them back again. He said to himself, "Do I still have four of them?" Please tell me (to children), how can we tell if the zookeeper still had all the animals back again?

Children count and answer. The story is presented twice again. The first time one animal is "lost", and the second time an animal is added to the group. In both cases, the zookeeper asks children to solve his problem.

To reiterate, the objective of the AO ad RA lessons sequence was (1) to instruct children in the concept of special property and how to locate and pay attention to a special property in an object (or set of objects), especially when the object (or set of objects) was changed in some way (transformation), and (2) to use the high-order-rule:

When an object (or set of objects) is changed in some way, and--when we are paying attention to a special property of that object (or set of objects)--

To find out if the special property has also changed, then--

CHECK TO SEE IF ANYTHING HAS BEEN ADDED TO, OR TAKEN AWAY FROM THAT SPECIAL PROPERTY.

If nothing has been added to or taken away from that special property, then--

THE SPECIAL PROPERTY HAS STAYED THE SAME.

Results

Posttest and delayed-posttest means and standard deviations for both groups are presented in Table 1 (attached). Preliminary t-test analyses indicated that there were no sex differences for both treatment groups at posttest and delayed-posttest.

A condition (2) x task (5) x time of testing (3) repeated measures analysis of variance was performed on the posttest data. The only main effect attaining significance was for between-group performance ($F = 13.81$, $df = 26$, $p<.05$). There were no interaction effects for time or tasks, suggesting that (1) the significant differences in performance between E and C groups at posttest was maintained four weeks later at delayed-posttest; (2) each treatment group scores across tasks at posttest and delayed-posttest were in close correspondence, being high for the E group and low for the C group.

Post hoc t-test analyses indicated significant between-groups differences in performance at posttest ($t = 3.96$, $df = 26$, $p<.05$) and at delayed-posttest ($t = 2.89$, $df = 26$, $p<.05$). T-test analyses between-ages and within groups were also performed. The results showed no significant differences between (a) control three- and four-year-old children at both posttest and delayed-posttest, or between (b) experimental three- and four-year-olds at both posttest and delayed-posttest.

The results of between-ages and between-groups analysis showed (a) no significant differences between control and experimental three-year-olds at posttest, but a significant difference at delayed-posttest ($t = 2.37$, $df = 11$, $p<.05$); and (b) a significant

difference between control and experimental four-year-olds at posttest ($t = 4.38$, $df. = 13$, $p<.05$) and at delayed-posttest ($t = 2.78$, $df = 13$, $p<.05$). In all cases, differences favored the E group children.

Pearson product moment correlations between posttest, and delayed-posttest mean scores on all tasks indicated that (a) for both E and C groups, performance at post- and delayed-posttests was very similar on all tasks, being high for E group children and low for C group children. It should be mentioned that compared to other conservation concepts, at both post- and delayed-posttests, performance on number conservation tasks was somewhat more advanced in the case of both treatment groups.

The data were also examined for the percentage of children passing each task at two times of testing (see Table 2 attached). The criterion for passing a task was success on both subtasks for each conservation concept. Data in Table 2 show that (a) a much greater percentage of E group children passed the five conservation tasks at both posttest and delayed-posttest; and, (b) there were no major differences in percentage of children passing each task for each group at posttest and delayed-posttest.

Discussion

The results of this study show that the AO + RA sequence of instruction was very successful in inducing in preschool children (1) an understanding of "special property", (2) an ability to isolate and pay attention to a special property in an object, or set of objects, with multiple properties, (3) an ability to observe the transformation of an object, or set of objects, and at the same time pay attention to

the identified special property of that object, or set of objects, (4) an ability to listen to a question asking whether, following a transformation, a special property had also been changed, and know how to apply the high-order rule of finding out whether the special property had changed or not by checking if anything had been added to, or taken away from that special property. If successful in this complete procedure, the child could respond that the special property had remained the same.

Success in training preschool children to attend to the crucial, special property to be observed in any conservation task, and ignore irrelevant properties lends support to the results of Gelman's study (1969). Gelman suggested that young children fail to pass conservation tasks because they tend to pay attention to irrelevant properties and changes. In Gelman's study, children were highly successful in solving conservation problems for which they had been trained to attend to relevant properties--namely, number and length. Success, indicated by percentage of correct scores, at pretest and delayed posttest for these tasks, and the non-specific transfer tasks of liquid and weight (mass) are shown in Figure 1 (see attached), and are compared to the results from this present study. We have to remember that the children in Gelman's study were aged 5 years, compared to children aged, on average, 3 years, 9 months, in the experimental group.

In this study, generalization was tested only in the context and limitation of five particular conservation concepts. It remains to be seen whether a general rule, taught within the context of a particular

partial class of problems might possibly generalize to other similar problems in that class such as the conservation of volume (usually found to be the most difficult of conservation problems) and weight.

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Table 1

Means and SD's for Each of Five Conservation Tasks at Post- and Delayed-Posttesting.

Time of Testing		E Group (N = 14) Mean	E Group (N = 14) SD	C Group (N = 14) Mean	C Group (N = 14) SD
Posttest	Number	1.79⁂	0.58	1.14	0.86
	Length	0.93	1.00	0.00	0.00
	Quantity	1.29	0.99	0.00	0.00
	Weight (mass)	0.93	0.92	0.14	0.36
	Area	0.93	0.87	0.00	0.73
Delayed Posttest	Number	1.71	0.73	1.43	0.94
	Length	1.21	1.04	0.21	0.58
	Quantity	1.17	0.92	0.14	0.53
	Weight (mass)	1.10	1.04	0.21	0.58
	Area	1.14	1.03	0.14	0.53

⁂ Score range for each task: 0-2.

Table 2

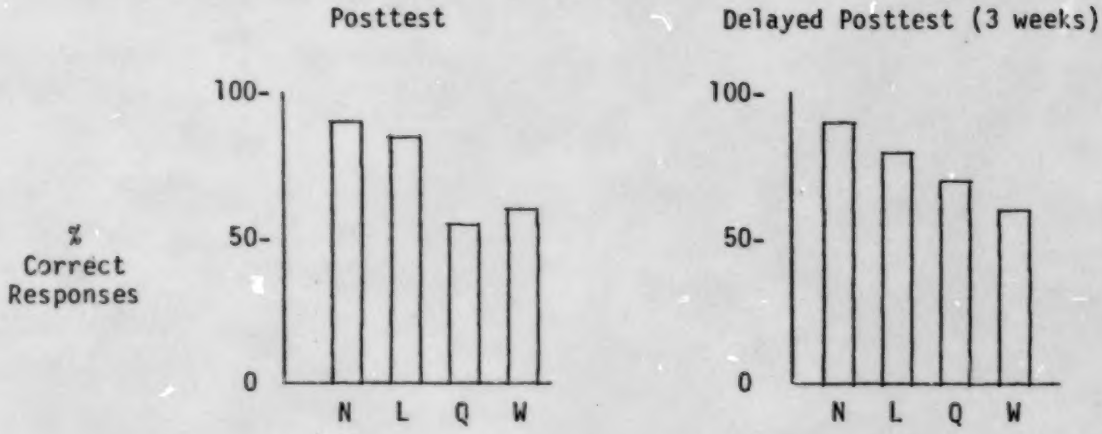
Percentage of Children Passing Each of Five Conservation Tasks at Post- and Delayed-Posttesting

Task	E Group Posttest	E Group Delayed Posttest	C Group Posttest	C Group Delayed Posttest
Number	84	84	32	37
Length	47	49	10	0
Quantity	63	58	0	0
Weight (mass)	37	42	0	0
Area	48	56	14	0

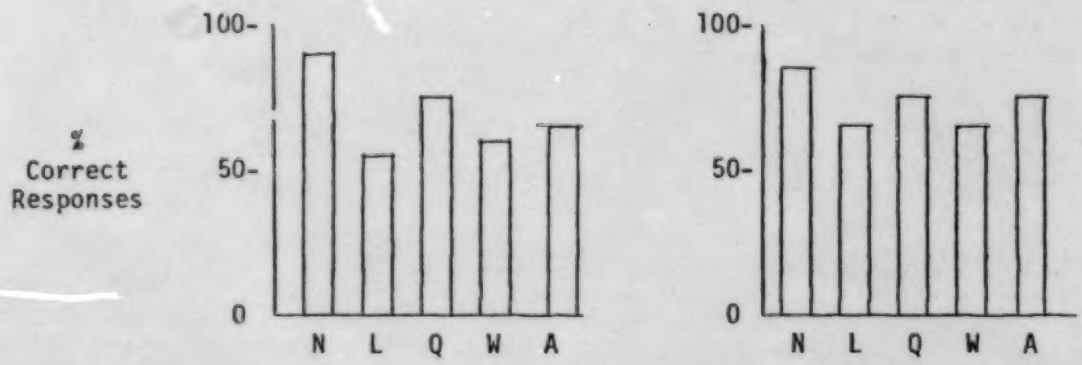
Criterion for passing each task was a score of 2 out of 2.

Figure 1

Comparison of Results from Gelman's Study and Present Study



Results of Gelman's Training Method (1969)



Results of Present Study (1983)

N = Number; L = Length; Q = Quantity; W = Weight (mass);
A = Area;